CLAIMS

1. An image processing device provided with a first image-taking mode used in a bright environment and a second image-taking mode used in a dark environment, comprising:

an iris for controlling a light quantity of an optical signal coming from outside;

an imaging element for outputting the optical signal from said iris as a video signal;

gain control means for performing gain control over the video signal from said imaging element;

signal processing means for signal-processing the output signal from said gain control means; and

imaging control means for controlling an opening degree of said iris, an exposure time of said imaging element and an amount of gain of said gain control means based on the video signal from said signal processing means,

wherein said imaging control means judges surrounding brightness based on the video signal from said signal processing means in the second image-taking mode and changes the exposure time in said imaging element in accordance with the brightness.

2. The image processing device according to claim 1, wherein the imaging control means controls over the opening degree of the iris when the surrounding brightness is brighter than a predetermined value and when the surrounding brightness is darker than the predetermined value.

3. The image processing device according to claim 1, wherein the imaging control means controls an amount of gain of the gain control means when the surrounding brightness is darker than a predetermined value.

4. An image processing device which forms an automatic search control loop whose period consists of M·Tf (= m·Tf+n·Tf, M: 1

and even number of 2 or greater) combining an electronic shutter ON-time m·Tf (m: positive number, Tf: 1-field period) and OFF-time n·Tf (n: positive number of 0 to 2), obtains and holds an exposure time corresponding to an imaging element which matches the brightness of an object, an iris value corresponding to an iris and an AGC gain value corresponding to an amplifier so as to set an optimum image taking condition.

5. An image processing device which enables image taking in a dark environment by setting an electronic shutter-ON time which is an exposure time of an imaging element to an m·Tf (m: positive number) period within a period M·Tf (M: 1 and even number of 2 or greater, Tf: 1-field period), comprising:

an imaging element made up of an imaging surface consisting of photoelectrical conversion elements for converting light to charge, an accumulation section for accumulating the charge generated from said photoelectrical conversion element and a charge transfer element for transferring the accumulated charge in vertical and horizontal directions and obtaining an image signal, said imaging element consecutively changing said exposure time m·Tf in a period M·Tf and automatically setting m·Tf to an optimum exposure time while maintaining a relationship:

$$M \cdot Tf = m \cdot Tf + n \cdot Tf$$

where n·Tf (n: positive number of 0 to 2) is an electronic shutter-OFF time;

a lens unit made up of a lens for forming an object image on the imaging surface of said imaging element and an iris or the like;

an imaging element driver which performs electronic shutter-ON drive control for accumulating charge from said charge transfer element in said accumulation section for said electronic shutter-ON time m·Tf, discharge drive control for discharging the charge from said accumulation section for said electronic shutter-OFF time n·Tf and drive control for

extracting an image signal of a last 1 field obtained for every said period M·Tf through vertical and horizontal transfers of said charge transfer element accumulated for said m·Tf time;

an amplifier which amplifies the image signal obtained from said imaging element through driving of said imaging element driver;

a signal processing circuit which signal-processes the image signal obtained from said amplifier to obtain a video signal made up of a brightness signal and color signal;

brightness detecting means for integrating said brightness signal indicating the light quantity value entering said imaging surface during said electronic shutter-ON time m·Tf for the last 1-field period of said exposure period and detecting the input light quantity value corresponding to the brightness of the object;

brightness reference setting means for setting a reference value of a brightness signal component corresponding to the brightness;

comparison means for comparing a brightness signal component value obtained from said brightness detecting means with the reference value of the brightness signal component from said brightness reference setting means and obtaining an error signal between both signals for every period M·Tf; and

imaging element control means,

wherein said imaging element control means comprises:

exposure memory means for storing the electronic shutter-ON time m·Tf set for every period M·Tf in memory;

exposure time calculation means for subjecting an exposure time correction amount Δm-1·Tf obtained through a calculation based on said error signal obtained 1 period ahead (M-1·Tf period) in a current period (M0·Tf period) during an electronic shutter-ON time m-1·Tf stored in the exposure memory means 1 period ahead (M-1·Tf period) of the current period (M0·Tf period) to addition or subtraction calculation processing according

to the sign of said error signal and calculating an electronic shutter-ON time m1·Tf (= m-1·Tf±Δm-1·Tf) in the next period (M1·Tf period); and

control signal generating means for storing said electronic shutter-ON time m1·Tf in said exposure memory means and generating a second control signal for extracting a 1-field image signal obtained by accumulating an electronic shutter-ON time supplied to said imaging element driver based on said electronic shutter-ON time m1·Tf and storing a first control signal indicating an electronic shutter-OFF period, and

first and second control signals generated based on said electronic shutter-ON time m·Tf from said control signal generating means are supplied to said imaging element driver, a feedback control loop is thereby formed during an M·Tf period, said electronic shutter-ON time m·Tf is changed and said electronic shutter-ON time (exposure time) m·Tf at a time point at which said error signal becomes zero or approximates to zero is held to thereby obtain a video signal under an optimum exposure condition.

6. The image processing device according to claim 5, further comprising:

memory means for obtaining a continuous video signal from said signal processing circuit by fixing the electronic shutter-ON time from the imaging element control means to a period 1 Tf in a normal image-taking mode and converting a 1-field video signal obtained periodically for every period M·Tf from said signal processing circuit to a continuous video signal in said high-sensitivity image-taking mode;

switch means for selecting a moving image video signal from said signal processing circuit in the normal image-taking mode and a video signal from said memory means in the high-sensitivity image-taking mode;

a mode switching button for generating a command signal for switching between said modes; and

mode signal generating means for generating a control signal for receiving the command signal from said mode switching button and changing said switch means and a control signal for changing the setting of said imaging element control means according to the mode.

7. The image processing device according to claim 5 or 6, wherein said brightness reference setting means comprises a data table of reference values of said brightness signal component indicating a reference of the brightness corresponding to an exposure time m·Tf,

the electronic shutter-ON time m·Tf stored in said exposure memory means is supplied to said brightness reference setting means;

a reference value of the brightness signal component corresponding to said exposure time m·Tf is selected from said data table,

the selected reference value of the brightness signal component and said brightness signal component value obtained from said brightness detecting means are supplied to said comparison means, and

an error signal between both signals is obtained.

8. The image processing device according to claim 5 or 6, wherein said imaging element control means comprises maximum exposure judging means and minimum exposure judging means for generating a control signal when the electronic shutter-ON time (exposure time) m·Tf stored in said exposure memory means becomes a maximum value and minimum value,

said amplifier is made up of an AGC circuit or the like,

said image processing device further comprising:

AGC gain control means comprising AGC gain value memory means for storing a gain value of said AGC circuit for every said period M·Tf (M is a maximum value), gain calculation means for obtaining an AGC gain value G1 (= G-1±ΔG) in the next period

by performing a subtraction or addition between an AGC gain correction value ΔG obtained through calculation processing based on said error signal obtained from said comparison means and an AGC gain value G-1 stored in said memory means in the preceding period at a time point (current period) at which said correction value is obtained in accordance with the sign of said error signal and minimum gain judging means for storing said AGC gain value G1 in said memory means, storing an AGC gain value for every period M·Tf (M is a maximum value) and generating a control signal when the AGC gain value G stored in said memory means becomes a minimum value;

an iris mechanism driver for driving said iris mechanism which mechanically controls an input light quantity;

iris control means comprising iris value memory means for storing an iris value given to said iris mechanism for every said period M·Tf (M is a maximum value), iris value calculation means for obtaining an iris value I1 (= I-1$\pm\Delta$1) in the next period by executing a subtraction or addition between an iris correction value ΔI obtained through calculation processing based on said error signal obtained by said comparison means and an iris value I-1 obtained from said iris value memory means in the preceding period at a time point (current period) at which said correction value is obtained according to the sign of said error signal and iris value judging means including iris value minimum value judging means and iris value specific value judging means for adding said iris value I1 to said iris value memory means, storing an iris value for every M·Tf (M is a maximum value) period in memory, judging whether the iris value I stored in said iris value memory means (I) is a minimum value or judging the value when the iris value becomes a specific value and generating a control signal, for controlling the brightness exceeding the range controlled by said gain control means up to the range controlled by said imaging element control means and a bright range (control for period 1 Tf) outside the control range of said imaging element control means; and

selection signal generating means for generating a control signal for determining a period of operating said imaging element control means or said AGC gain control means or said iris control means using a control signal generated when a maximum value, minimum value and specific value stored in the respective memory means in accordance with the input light quantity are reached at said respective control means,

wherein a control loop is formed by supplying an AGC gain value G stored in said AGC gain value memory means of said gain control means to an AGC amplifier of said amplifier, an iris value I stored in said iris value memory means is supplied to said iris mechanism driver, a control loop is formed by setting an iris value, said selection signal generating means changes an operation period of said AGC gain control means, said iris control means and said imaging element control means according to the brightness, and when said error signal at any one control means in operation approximates to a zero value, memory means provided for the control means holds the value, sets an optimum image taking condition and obtains a clear video signal over the entire area of the brightness.

9. The image processing device according to claim 5 or 6, wherein said brightness reference setting means includes a data table of reference values of said brightness signal component indicating a reference of the brightness corresponding to an exposure time m·Tf, the exposure time m·Tf stored by said exposure memory means is supplied to said brightness reference setting means, a reference value of the brightness signal component corresponding to said exposure time m·Tf is selected from said data table and the selected reference value of the brightness signal component and said brightness signal component value obtained from said brightness detecting means are supplied to said comparison means so as to obtain an error signal between both signals,

said imaging element control means comprises maximum exposure judging means and minimum exposure judging means for generating a control signal when the electronic shutter-ON time (exposure time) m·Tf stored in said exposure memory means becomes a maximum value and minimum value,

said amplifier is made up of an AGC circuit or the like,

said image processing device further comprising:

AGC gain control means comprising AGC gain value memory means for storing a gain value of said AGC circuit for every said period M·Tf (M is a maximum value), gain calculation means for obtaining an AGC gain value G1 (= G-1±ΔG) in the next period by performing a subtraction or addition between an AGC gain correction value ΔG obtained through calculation processing based on said error signal obtained from said comparison means and an AGC gain value G-1 stored in said memory means in the preceding period at a time point (current period) at which said correction value is obtained in accordance with the sign of said error signal and minimum gain judging means for storing said AGC gain value G1 in said memory means, storing an AGC gain value for every period M·Tf (M is a maximum value) and generating a control signal when the AGC gain value G stored in said memory means becomes a minimum value;

an iris mechanism driver for driving said iris mechanism which mechanically controls an input light quantity;

iris control means comprising iris value memory means for storing an iris value given to said iris mechanism for every said period M·Tf (M is a maximum value), iris value calculation means for obtaining an iris value I1 (= I-1±Δ1) in the next period by executing a subtraction or addition between an iris correction value ΔI obtained through calculation processing based on said error signal obtained by said comparison means and an iris value I-1 obtained from said iris value memory means in the preceding period at a time point (current period) at which said correction value is obtained according to the sign of said error signal and iris value judging means including

iris value minimum value judging means and iris value specific value judging means for adding said iris value I1 to said iris value memory means, storing an iris value for every M·Tf (M is a maximum value) period in memory, judging whether the iris value I stored in said iris value memory means (I) is a minimum value or judging the value when the iris value becomes a specific value and generating a control signal, for controlling the brightness exceeding the range controlled by said gain control means up to the range controlled by said imaging element control means and a bright range (control for period 1 Tf) outside the control range of said imaging element control means; and

selection signal generating means for generating a control signal for determining a period of operating said imaging element control means or said AGC gain control means or said iris control means using a control signal generated when a maximum value, minimum value and specific value stored in the respective memory means in accordance with the input light quantity are reached at said respective control means,

wherein a control loop is formed by supplying an AGC gain value G stored in said AGC gain value memory means of said gain control means to an AGC amplifier of said amplifier, an iris value I stored in said iris value memory means is supplied to said iris mechanism driver, a control loop is formed by setting an iris value, said selection signal generating means changes an operation period of said AGC gain control means, said iris control means and said imaging element control means according to the brightness, and when said error signal at any one control means in operation approximates to a zero value, memory means provided for the control means holds the value, sets an optimum image taking condition and obtains a clear video signal over the entire area of the brightness.

10. The image processing device according to claim 5 or 6, wherein said imaging element control means comprises maximum exposure judging means and minimum exposure judging means for

generating a control signal when the electronic shutter-ON time (exposure time) m·Tf stored in said exposure memory means becomes a maximum value and minimum value,

said amplifier is made up of an AGC circuit or the like,

said image processing device further comprising:

AGC gain control means comprising AGC gain value memory means for storing a gain value of said AGC circuit for every said period M·Tf (M is a maximum value), gain calculation means for obtaining an AGC gain value G1 (= G-1±ΔG) in the next period by performing a subtraction or addition between an AGC gain correction value ΔG obtained through calculation processing based on said error signal obtained from said comparison means and an AGC gain value G-1 stored in said memory means in the preceding period at a time point (current period) at which said correction value is obtained in accordance with the sign of said error signal and minimum gain judging means for storing said AGC gain value G1 in said memory means, storing an AGC gain value for every period M·Tf (M is a maximum value) and generating a control signal when the AGC gain value G stored in said memory means becomes a minimum value;

an iris mechanism driver for driving said iris mechanism which mechanically controls an input light quantity;

iris control means comprising iris value memory means for storing an iris value given to said iris mechanism for every said period M·Tf (M is a maximum value), iris value calculation means for obtaining an iris value I1 (= I-1±Δ1) in the next period by executing a subtraction or addition between an iris correction value ΔI obtained through calculation processing based on said error signal obtained by said comparison means and an iris value I-1 obtained from said iris value memory means in the preceding period at a time point (current period) at which said correction value is obtained according to the sign of said error signal and iris value judging means including iris value minimum value judging means and iris value specific value judging means for adding said iris value I1 to said iris

value memory means, storing an iris value for every M·Tf (M is a maximum value) period in memory, judging whether the iris value I stored in said iris value memory means (I) is a minimum value or judging the value when the iris value becomes a specific value and generating a control signal, for controlling the brightness exceeding the range controlled by said gain control means up to the range controlled by said imaging element control means and a bright range (control for period 1 Tf) outside the control range of said imaging element control means; and

selection signal generating means for generating a control signal for determining a period of operating said imaging element control means or said AGC gain control means or said iris control means using a control signal generated when a maximum value, minimum value and specific value stored in the respective memory means in accordance with the input light quantity are reached at said respective control means,

wherein a control loop is formed by supplying an AGC gain value G stored in said AGC gain value memory means of said gain control means to an AGC amplifier of said amplifier, an iris value I stored in said iris value memory means is supplied to said iris mechanism driver, a control loop is formed by setting an iris value, said selection signal generating means changes an operation period of said AGC gain control means, said iris control means and said imaging element control means according to the brightness, and when said error signal at any one control means in operation approximates to a zero value, memory means provided for the control means holds the value, sets an optimum image taking condition and obtains a clear video signal over the entire area of the brightness, and

said mode signal generating means comprises:

a data table for setting the electronic shutter-ON time to a maximum value for said imaging element control means, the AGC gain to a maximum value for said gain control means and the iris value to a minimum value for said iris control means; and

generating means for generating a control means selection start signal for said selection signal generating means,

wherein when a command signal of said mode switching button is received and the normal image-taking mode is switched to the high-sensitivity image-taking mode, the values of said data table are supplied to said respective control means and a start signal is supplied to said selection signal generating means and control is started from said gain control means so as to converge to an optimum exposure condition.

11. The image processing device according to claim 5 or 6, wherein said brightness reference setting means includes a data table of reference values of said brightness signal component indicating a reference of the brightness corresponding to an exposure time m·Tf, the exposure time m·Tf stored by said exposure memory means is supplied to said brightness reference setting means, a reference value of the brightness signal component corresponding to said exposure time m·Tf is selected from said data table and the selected reference value of the brightness signal component and said brightness signal component value obtained from said brightness detecting means are supplied to said comparison means so as to obtain an error signal between both signals,

said imaging element control means comprises maximum exposure judging means and minimum exposure judging means for generating a control signal when the electronic shutter-ON time (exposure time) m·Tf stored in said exposure memory means becomes a maximum value and minimum value,

said amplifier is made up of an AGC circuit or the like,

said image processing device further comprising:

AGC gain control means comprising AGC gain value memory means for storing a gain value of said AGC circuit for every said period M·Tf (M is a maximum value), gain calculation means for obtaining an AGC gain value G1 (= G-1±ΔG) in the next period by performing a subtraction or addition between an AGC gain

correction value ΔG obtained through calculation processing based on said error signal obtained from said comparison means and an AGC gain value G-1 stored in said memory means in the preceding period at a time point (current period) at which said correction value is obtained in accordance with the sign of said error signal and minimum gain judging means for storing said AGC gain value G1 in said memory means, storing an AGC gain value for every period M·Tf (M is a maximum value) and generating a control signal when the AGC gain value G stored in said memory means becomes a minimum value;

an iris mechanism driver for driving said iris mechanism which mechanically controls an input light quantity;

iris control means comprising iris value memory means for storing an iris value given to said iris mechanism for every said period M·Tf (M is a maximum value), iris value calculation means for obtaining an iris value I1 (= I-1±Δ1) in the next period by executing a subtraction or addition between an iris correction value ΔI obtained through calculation processing based on said error signal obtained by said comparison means and an iris value I-1 obtained from said iris value memory means in the preceding period at a time point (current period) at which said correction value is obtained according to the sign of said error signal and iris value judging means including iris value minimum value judging means and iris value specific value judging means for adding said iris value I1 to said iris value memory means, storing an iris value for every M·Tf (M is a maximum value) period in memory, judging whether the iris value I stored in said iris value memory means (I) is a minimum value or judging the value when the iris value becomes a specific value and generating a control signal, for controlling the brightness exceeding the range controlled by said gain control means up to the range controlled by said imaging element control means and a bright range (control for period 1 Tf) outside the control range of said imaging element control means; and

selection signal generating means for generating a control signal for determining a period of operating said imaging element control means or said AGC gain control means or said iris control means using a control signal generated when a maximum value, minimum value and specific value stored in the respective memory means in accordance with the input light quantity are reached at said respective control means,

wherein a control loop is formed by supplying an AGC gain value G stored in said AGC gain value memory means of said gain control means to an AGC amplifier of said amplifier, an iris value I stored in said iris value memory means is supplied to said iris mechanism driver, a control loop is formed by setting an iris value, said selection signal generating means changes an operation period of said AGC gain control means, said iris control means and said imaging element control means according to the brightness, and when said error signal at any one control means in operation approximates to a zero value, memory means provided for the control means holds the value, sets an optimum image taking condition and obtains a clear video signal over the entire area of the brightness, and

said mode signal generating means comprises:

a data table for setting the electronic shutter-ON time to a maximum value for said imaging element control means, the AGC gain to a maximum value for said gain control means and the iris value to a minimum value for said iris control means; and

generating means for generating a control means selection start signal for said selection signal generating means,

wherein when a command signal of said mode switching button is received and the normal image-taking mode is switched to the high-sensitivity image-taking mode, the values of said data table are supplied to said respective control means and a start signal is supplied to said selection signal generating means and control is started from said gain control means so as to converge to an optimum exposure condition.